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Picloram: A Promising Brush Control Chemical[1]

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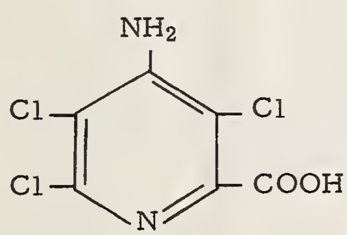
Picloram (4-amino-3,5,6-trichloropicolinic acid) was recently reported as a plant growth regulator that is more toxic to broad-leaved plants than to grasses.[3] The structural formula of picloram is as follows:



The solubility of picloram in water at 25°C. is 430 p.p.m.; the potassium salt is highly soluble in water.

The potassium salt of picloram[4] in liquid formulation was evaluated in greenhouse studies for the control of shrub live oak (Quercus turbinella Greene). This shrub, which composes 60 to 80 percent of the chaparral type in Arizona, is one of the most difficult species to control. Interest in its control arises from a desire to increase water yield and forage production.

Picloram was applied on April 9, 1963, to the soil around 2-year-old shrub live oak plants in gallon cans. The soil was a sandy loam. The chemical, applied at rates of 1, 2, 4, 8, and 16 pounds per acre, was compared with 3-phenyl-1, 1-dimethylurea (fenuron)[5] at the same rates. The chemicals were applied as drenches to the soil, in 1/4 inch of water. Each treatment was replicated 4 times, so that 20 plants were treated with each chemical. The soil was subsequently kept moist by uniform irrigations with measured amounts of water, usually applied in 1/4-inch increments. When the data for all rates of each chemical were pooled, picloram killed 80 percent of the plants and fenuron killed 70 percent. The two chemicals were comparable at the higher rates, but at the lower rates picloram was superior. The pooled toxicity index for all rates was 90 for picloram and 78 for fenuron. The toxicity index is the average of percent dead plants and percent growth reduction.

To evaluate the effect of picloram on grass and its persistence in soil, oats were planted 4 days after treatment and again after 6, 15, and 20 weeks. Picloram was less toxic to oats than was fenuron, but the persistence of the two chemicals was comparable. After 15 weeks, yields of oats were normal in the soil initially treated with 1, 2, and 4 pounds per acre of either picloram or fenuron. After 20 weeks, the mean percent inhibition of oats for all rates (1 to 16 pounds per acre) was 17.8 percent for picloram and 19.0 percent for fenuron.

In another test, conducted with 4-year-old shrub live oak plants, picloram and fenuron were applied as drenches to the soil in 1/4 inch of water, at rates of 2 and 4 pounds per acre. There were two plants per treatment. The chemicals were applied on April 3, 1963, and the soil was then watered regularly as before. The effects of the chemicals were complete after 3-1/2 months. When the data for both rates were pooled, picloram and fenuron killed 75 and 25 percent of the plants, respectively. The mean percentages of stem dieback, original-leaf injury, and growth reduction were considerably higher for picloram than for fenuron. The pooled toxicity indexes were 82 for picloram and 32 for fenuron.

Picloram did not inhibit oats planted in the soil 10 days after treatment, but the 2 and 4 pounds per acre treatments of fenuron caused 27 and 91 percent inhibition, respectively. A summary of overall results for soil-applied treatments comparing 2,3,6-trichloropicolinic acid (picloram) and fenuron for the control of potted shrub live oak plants is as follows:

	Picloram (Percent)	Fenuron (Percent)
2-year-old plants: (Pooled data for treatments of 1, 2, 4, 8, and 16 pounds per acre)		
Dead plants	80	70
Growth reduction	99	86
Toxicity index (average of percent dead plants and percent growth reduction)	90	78
Inhibition of oats after 20 weeks	18	19
4-year-old plants: (Pooled data for treatments of 2 and 4 pounds per acre)		
Dead plants	75	25
Growth reduction	88	40
Toxicity index	82	32
Inhibition of oats after 10 days	0	59

Low-volume foliage sprays of picloram were compared with the butoxy ethanol ester of 2,4,5-trichlorophenoxyacetic acid (2,4,5-T)[6] in which the soil as well as the plants received spray. The chemicals were applied to 2-year-old plants on April 4, 1963, at rates of 1/16 to 2 pounds per acre in 10 gallons per acre in a 2x geometric progression. Neither picloram nor 2,4,5-T at rates up to 2 pounds per acre effectively controlled shrub live oak. The effects of the two chemicals were very different. The 2,4,5-T caused stem dieback and severe leaf injury, whereas picloram did not. However, picloram at 1/2 to 2 pounds per acre inhibited regrowth to a greater extent than 2,4,5-T at the same rates. The morphological characteristics of the regrowth of picloram-treated plants were similar to those which are produced by another herbicide, 2,3,6-trichlorobenzoic acid.

To determine the extent of the foliage activity of picloram the tops of 2-year-old shrub live oak plants were sprayed to the point of runoff, while the bottom 5 inches of stem and the soil were protected from spray. The plants were sprayed with 0.0375 to 2.4 percent solutions of picloram in a 2x geometric progression. These wetting sprays, which were restricted to the leaves and stems, resulted in complete leaf kill even at the lowest concentration of 375 p.p.m., whereas the former low-volume sprays of 1/16 to 2 pounds per acre in 10 gallons, ranging in concentration from 750 to 24,000 p.p.m., caused only minor leaf damage. The effect of the wetting foliage sprays on plant survival was extremely erratic; there was no consistent relation between chemical concentration and plant kill. Of the 21 plants sprayed, 9 were killed (42.9 percent).

Although the results of this study indicate that a single low-volume spray (such as an aerial application) probably would not be effective for eradicating shrub live oak, they suggest that high-volume sprays with ground equipment may be of value. Picloram was active through both the roots and shoots of shrub live oak. This plant was much more effectively controlled, however, when picloram was applied to the soil rather than to the foliage. Picloram can be applied conveniently to the soil as pellets.

On the basis of these preliminary studies, conducted in the greenhouse, picloram shows considerable promise as a brush control chemical in Arizona.

[1]Research reported here was conducted while author was employed by Crops Research Division, Agricultural Research Service, U. S. Department of Agriculture. Mention of trade names and commercial enterprises or products is solely for necessary information. No endorsement by the U. S. Department of Agriculture is implied.

[2]Plant Physiologist, located at Tempe, in cooperation with Arizona State University; central headquarters maintained at Fort Collins, in cooperation with Colorado State University.

[3]Hamaker, J. W., Johnston, H., Martin, R. T., and Redemann, C. T. A picolinic acid derivative: A plant growth regulator. Science 141: 363-364. 1963.

[4]An experimental sample of 4-amino-3,5,6-trichloropicolinic acid, under the trademark Tordon, was supplied as the potassium salt by The Dow Chemical Co., Midland, Michigan.

[5]Fenuron, as an 80 percent wettable powder formulation, was provided by the E. I. du Pont de Nemours & Co., Wilmington, Delaware.

[6]The butoxy ethanol ester of 2, 4, 5-trichlorophenoxyacetic acid was donated by Amchem Products Inc., Ambler, Pennsylvania.

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